Abstract Submitted
for the DFD15 Meeting of
The American Physical Society

Liquid spreading on ceramic-coated carbon nanotube films and patterned microstructures[1] HANGBO ZHAO, A. JOHN HART, Massachusetts Institute of Technology — We study the capillary-driven liquid spreading behavior on films and microstructures of ceramic-coated vertically aligned carbon nanotubes (CNTs) fabricated on quartz substrates. The nanoscale porosity and micro-scale dimensions of the CNT structures, which can be precisely varied by the fabrication process, enable quantitative measurements that can be related to analytical models of the spreading behavior. Moreover, the conformal alumina coating by atomic layer deposition (ALD) prevents capillary-induced deformation of the CNTs upon meniscus recession, which has complicated previous studies of this topic. Washburn-like liquid spreading behavior is observed on non-patterned CNT surfaces, and is explained using a scaling model based on the balance of capillary driving force and the viscous drag force. Using these insights, we design patterned surfaces with controllable spreading rates and study the contact line pinning-depinning behavior. The nanoscale porosity, controllable surface chemistry, and mechanical stability of coated CNTs provide significantly enhanced liquid-solid interfacial area compared to solid microstructures. As a result, these surface designs may be useful for applications such as phase-change heat transfer and electrochemical energy storage.

[1]Funding for this project is provided by the National Institutes of Health and the MIT Center for Clean Water and Clean Energy supported by the King Fahd University of Petroleum and Minerals.

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Date submitted: 01 Aug 2015 Electronic form version 1.4